HIGH COVERAGE COOLING HOLE SHAPE

BACKGROUND OF THE INVENTION

[0001] This application relates a cooling hole formed within a gas turbine engine component, such as a turbine blade for example, where the cooling hole is shaped to improve cooling effectiveness.

[0002] Gas turbine engines include many different types of components that are subjected to high thermal stresses. One example of such a component is a turbine blade. As known, a turbine blade typically includes a platform, with an airfoil body extending above the platform. The airfoil body is curved, extending from a leading edge to a trailing edge. Moreover, there is a pressure side and a suction side to the airfoil body. The pressure side becomes much hotter than the suction side during operation.

[0003] Cooling channels or holes are formed within the airfoil body to circulate cooling air. A cooling hole extends from a first surface of the airfoil body, through a thickness of the airfoil body, and is open to a second surface of the airfoil body. One traditional type of cooling hole has a circular cross-section extending from the first surface to the second surface.

[0004] A known improvement to this traditionally shaped cooling hole is a hole that has a trapezoidal shape at one of the first and second surfaces. This shape provides improved cooling but is difficult and time consuming to manufacture. Further, while this trapezoidal shape provides improved cooling, there is a need for even greater cooling capability for components in a gas turbine engine that are subjected to thermal stresses.

[0005] Thus, there is a need for an improved cooling hole shape that provides more effective cooling, and which can be easily manufactured.

SUMMARY OF THE INVENTION

[0006] In a disclosed embodiment of this invention, a cooling hole is formed within a component for a gas turbine engine. The component has a first outer surface and a second outer surface separated from each other by a thickness. The cooling hole extends through the thickness from a first opening at the first outer surface to a second opening at the second outer surface. At least one of the first and second openings has a bi-lobed shape.

[0007] In one disclosed embodiment, the first and second openings are defined by shapes that are different from each other. In one example, one of the first and second openings has the bi-lobed shape and the other of the first and second openings has a circular shape.

[0008] In one disclosed embodiment, parameters defining the bi-lobed shape are varied to optimize dimensions for the bi-lobed shape. In one example, a plurality of radii are used to define the bi-lobed shape, and the radii values are varied to optimize cooling for an associated component.

[0009] The bi-lobed shape of the cooling hole improves cooling effectiveness and can be easily formed within a component by rapid electrical discharge machining (EDM), laser drilling, or other similar processes. These and other features of the present invention can be best understood from the following specification and drawings, the following of which is a brief description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. **1** is a schematic of a gas turbine engine incorporating the present invention.

[0011] FIG. **2**A is a view of a single turbine blade.

[0012] FIG. **2**B is a cross-section of an airfoil of the turbine blade of FIG. **2**A.

[0013] FIG. **3** is an example of a cooling hole formed within a gas turbine engine component.

[0014] FIG. **4** is an end view of the cooling hole of FIG. **3**.

[0015] FIG. **5**A is a top view of the cooling hole of FIG. **4**.

[0016] FIG. **5**B is an end view of the cooling hole of FIG. **5**A.

[0017] FIG. **5**C is a bottom view of the cooling hole of FIG. **5**A.

[0018] FIG. **6** is a flowchart defining a method for optimizing a shape of the cooling hole.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0019] FIG. **1** shows a gas turbine engine **10**, such as a gas turbine used for power generation or propulsion, circumferentially disposed about an engine centerline, or axial centerline axis **12**. The engine **10** includes a fan **14**, a compressor **16**, a combustion section **18** and a turbine **20**. As is well known in the art, air compressed in the compressor **16** is mixed with fuel which is burned in the combustion section **18** and expanded in turbine **20**. The air compressed in the compressor **16** and the fuel mixture expanded in the turbine **20** can both be referred to as a hot gas stream flow. The turbine **20** includes rotors **22** and **24** that, in response to the expansion, rotate, driving the compressor **16** and fan **14**. The turbine **20** comprises alternating rows of rotary blades **26** and static airfoils or vanes **28**. FIG. **1** is a somewhat schematic representation, for illustrative purposes only, and is not a limitation of the instant invention, that may be employed on gas turbines used for electrical power generation and aircraft.

[0020] FIG. **2**A shows blade **26** having a platform **30**. As is known, a curved airfoil **32** extends upwardly from the platform **30**.

[0021] As shown in FIG. **2**B, the airfoil **32** has a leading edge **34** and a trailing edge **36**. A pressure side **38** contacts a hotter fluid than a suction side **40**. As shown in FIG. **3**, at least one cooling hole **50** is formed within the airfoil **32** to provide a cooling flow path through the airfoil **32**. It should be understood that while only one cooling hole is shown, additional cooling holes are typically provided to provide cooling flow paths throughout the airfoil **32**. Further, while the cooling hole is show in the example of a rotating turbine blade, it should be understood that the cooling hole could also be utilized in other gas turbine engine components such as static airfoils, vanes, etc., which are subjected to thermal stresses.

[0022] As shown in FIG. **3**, the airfoil **32** has an outer surface **52** and an inner surface **54** separated by a thickness. The cooling hole **50** extends through the thickness and has a first opening **56** at the outer surface **52** and a second opening **58** at the inner surface **54**. In the example shown,